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The impact of injuries on health service resource use and costs in primary and secondary care in the English NHS

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ABSTRACT

Background Injuries in working age adults are common, but few studies examine NHS resource use or costs.

Methods Costing study based on a cohort of 16- to 70-year olds admitted to hospital following unintentional injury in NHS Trusts in four UK centres. Participants completed resource-use questionnaires up to 12 months post-injury. Primary and secondary care, aids, adaptations, appliances and prescribed medications were costed. Mean costs by injury type and age group and costs per clinical commissioning group (CCG) were estimated.

Results A total of 668 adults participated. Follow-up rates ranged from 77% at 1 month to 65% at 12 months. The mean cost of injuries over 12 months was £4691 per participant. Costs were highest for hip fractures (£5159), lower limb fractures (£4969) and multiple injuries (£4969). Secondary care accounted for 87% of mean costs across all injuries and primary care for 10%. The mean cost per CCG was £7.3 million (range £1.8 million–£25.6 million). The total cost across all English CCGs was £1.53 billion.

Conclusions Unintentional injuries in working age adults result in high levels of NHS resource use and costs in the year following injury. Commissioning effective injury prevention interventions may reduce these costs.

Keywords costs, primary care, secondary care, service use, unintentional injuries

Introduction

In 2012, injuries were responsible for over 11 000 deaths in England and Wales[1] and in 2012/13 for >660 000 admissions to English hospitals, accounting for >3 million bed days.[2] Annually in the UK, over 5.8 million people attend an emergency department (ED) following unintentional injuries,[3] which account for 760 000 disability adjusted life years lost.[4] Unintentional injuries are especially problematic in working age adults comprising 43% of deaths, 45% of hospital admissions and 50% of ED attendances.[1–3] Injuries impact substantially on primary care services; one-third of ED attenders following an injury will consult with a GP or practice nurse in the first month and 21% will still be consulting 4 months post-injury. Among injured patients admitted to hospital, these figures are higher (58% within the first month and 36% still consulting 4 months post-injury[5]). Recovery can also be prolonged; a recent UK study with a wide range of injured people

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attending ED or hospital admitted found only 28% were fully recovered at 1 month, 54% at 4 months and 71% at 12 months.[6]

Although injuries create an economic burden for society, health services and patients, few UK studies directly report their costs. This prevents prioritization of injury prevention, limits policy and strategy development, and health service planning and commissioning. Two studies have estimated direct medical costs of injury for general injury populations in the UK. The EUROCOST study estimated costs of ED attended and hospital admitted injuries in Europe, including England and Wales using data from 1999.[7] Injuries across all age groups and injury intents were included. Admissions for late consequences of injury and medical adverse events were excluded. Costs for ambulance transport, rehabilitation, nursing home care, outpatient care and home care were inestimable. Total costs for ED attendances were €948 and €965 million for hospital admissions, amounting to 2.5% of England annual total health expenditure. The patient mean cost for an ED attended injury was €156 and €1418 for a hospital admission. Injuries in women incurred higher costs and half of all admission costs were for those aged 65 years and older. Highest cost injuries per patient were hip/pelvis/femoral shaft fractures, burns, complex soft tissue injuries of the lower limb, fractures of the knee or lower leg and vertebral column/spinal cord injuries and upper arm fractures.[8] The APOLLO project used the EUROCOST methodology in seven EU countries, including Wales, using 2005 data. The total annual cost for admitted patients was €90 million. Age and sex findings were similar to those of the EUROCOST study. Highest cost per patient injuries were fractures of the hip, femur, pelvis, ankle and upper arm.[9] Both studies relied on secondary care data, therefore underestimating NHS costs by excluding primary care. Furthermore, the injury incidence and cost data used in these studies are now dated. The analyses presented in this paper report more up-to-date costs of primary and secondary healthcare NHS services up to 1 year post-injury for a general injury population.

Methods

We report findings from the Impact of Injuries study (protocol describes the methods in full[10]). Participants were aged 16–70 years admitted for an unintentional injury to acute NHS hospitals in Nottingham, Bristol, Leicester and Guildford and recruited either while admitted or by posting a questionnaire and consent form within 3 weeks of their injury. People without a permanent address (due to inability to follow-up), those not allowing access to medical records or giving informed consent, and those with significant head injuries (loss of consciousness, amnesia or a Glasgow coma scale of <15) were excluded. Study recruitment lasted from June 2010 to June 2012 (using quota sampling between June 2010 and May 2011 and invitation to all eligible patients from June 2011 due to slower than expected recruitment). Follow-up data collection was completed in July 2013.

Participants completed baseline questionnaires at recruitment and follow-up questionnaires at 1, 2, 4 and 12 months post-injury on socio-demographic and economic characteristics, injury details, the use of health services, medication, aids and home adaptations (thereafter equipment) for injury-related reasons. At each follow-up time point, questions on health service use and costs related to the time period since the last questionnaire was completed. Length of stay for the index admission was obtained from medical records. Where participants reported hospital admissions or ED attendances for injury in the 1-month follow-up questionnaire, we used reasons given to differentiate between index admission or attendance or a re-admission or re-attendance.

Drug costs were calculated using standard health economics methods,[11] and participant reported data on named drugs and drug use length. We used the Defined Daily Dose (DDD), or if not available, the Average Daily Quantity (ADQ),[12] both of which are the assumed average maintenance daily dose for a drug used for its main indication in adults,[13] to estimate the total number of daily units per drug. This was multiplied by the maximum number of days recommended by the British National Formulary (BNF)[14] to get a total number of units. The unit cost per drug was obtained from the BNF and multiplied by the total number of units to estimate total cost.

We assigned costs to resource use based on the PSSRU annual survey of Unit Costs of Health and Social Care,[15] the NHS tariff,[16] the BNF[14] and a variety of sources to cost equipment (shown in Supplementary data, Tables S1 and 2). We multiplied 'units' of resources used by 'price weights' to give 'unit costs'. For instance, 1 h of specialist nurse (including travel) costs £43. Therefore, a 25 min consultation unit cost is £17.92. We took an NHS perspective, which involved accounting for the use of NHS resources only (not including patient or other expenditure). We estimated average costs for each resource used by calculating the total cost for each type of resource and dividing by the total number of participants who completed all follow-up questionnaires ($n = 328$), described using means, standard deviations and ranges. We included non-users of services in the denominator, because NHS commissioners are interested in average costs per patient rather than average cost per user (which may be of more interest to service providers) as this allows estimation of costs for a patient population. We also described average costs by type of injury using means, standard deviations and ranges.

We used multiple imputations with chained equations to impute missing costs at 1, 2, 4 and 12 months follow-up. The imputation model included separate costs at each time point

for primary care, secondary care, equipment and medications. The imputation model included also study centre and baseline characteristics (age, sex, ethnicity, IMD score, EQ5D utility index, employment, marital status, long-standing illness) and injury characteristics (nights in hospital, type of injury, severity, location, mechanism, secondary care costs of admission). Fifty imputed data sets were generated.

We estimated costs at Clinical Commissioning Group (CCG) level by calculating 5-year, age-specific hospital admission rates[2] for ICD-10 codes V01-X59 based on the total population across all 211 England CCGs,[17] multiplying this rate by the 5-year, age-specific population figures for each CCG and then multiplying this by the average NHS cost for injured participants in each 5-year age band. Then we summed these costs across the age bands to give a total estimated cost per CCG. To ensure average costs reflected the full range of injuries requiring admission to hospital, this analysis only used data from participants recruited from June 2011 onwards, when all interested and eligible participants were invited. In addition, as for all cost analyses presented, it is restricted to participants who completed all follow-up questionnaires ($n = 207$). We described costs at CCG level using the mean, standard deviation and range and histogram illustration.

Results

The study recruited 668 participants: 77% completed follow-up at 1 month and 63% at 12 months, with 49% returning all four follow-up questionnaires (Supplementary data, Figure S1). Table 1 shows that most participants were aged 25–64 (73%), 53% were males, 60% were in paid employment and 25% had a limiting long-standing illness. Falls (64%) and road traffic (21%) were the most common injury mechanisms. Lower limb (45%) and upper limb fractures (11%) were the most common injury types. Most injuries (71%) were of moderate severity. The median number of hospital nights at index admission was 6 (IQR 3, 10).

NHS services use in the year after injury is shown in Table 2. GP consultations were the most commonly used primary/community care service at all time points, used by 25% of participants in the first month and still used by 34% at 5–12 months post-injury. Over 20% of participants used telephone consultations with GPs or practice nurses in the first 2 months post-injury. Community physiotherapy was used by between 7 and 17% of participants, most commonly at 3–4 months and by 12% at 5–12 months. Overall, 67% of participants used at least one primary care service in the first month, with 61, 60 and 47% still using services at 1–2, 3–4 and 5–12 months, respectively. In terms of secondary care, 6–12% had an ED re-attendance and 5–9% had a hospital readmission across the four follow-up time points. Fracture clinic was the service most commonly used, by between 34 and 70% of participants, most commonly in the first 4 months, with 34% still attending 5–12 months post-injury. Hospital physiotherapy was used by between 23 and 51% of participants, most commonly between 2 and 4 months, with 37% still attending 5–12 months post-injury. Overall, 80% used at least one secondary care service in the first month, with 89, 81 and 62% still using services at 1–2, 3–4 and 5–12 months, respectively.

Table 3 shows that equipment were most commonly provided in the first 2 months post-injury; crutches, walking frames and toilet modifications were most commonly used. In the first month, 88% of participants were prescribed injury-related medication, as were 61, 47 and 35% at 1–2, 3–4 and 5–12 months, respectively. Central nervous system and musculoskeletal and joint disease injury-related medications were the most commonly prescribed across time points.

Average costs by injury type in the 328 participants who returned all follow-up questionnaires are shown in Table 4. The mean cost over 12 months across all services and injury types was £4691 (SD = £2342). Hip fractures incurred the highest mean cost (£5159), followed by lower extremity fractures (£4969) and multiple injuries (£4969). The highest mean primary care costs were for hip fracture (£1102) and multiple injuries (£527). The highest mean secondary care costs were for lower extremity fractures (£4397) and multiple injuries (£4299). The highest mean equipment costs were for hip fractures (£167) and multiple injuries (£72). The highest mean medication costs were for spine/vertebrae fractures (£103) and hip fractures (£96). The mean cost (and percentage of total mean cost) across all injuries was £454 (10%) for primary care, £4097 (87%) for secondary care, £67 (1%) for equipment and £73 (2%) for medication.

Mean costs based on multiply imputed data (Supplementary data, Table S3) tended to be slightly higher than the costs from the complete case analyses; for example, the mean total cost over 12 months across all services was £4881.

Estimating costs per CCG

The mean costs by injury type and the total mean costs across all injury types in the 207 participants who completed all follow-up questionnaires and were not recruited using quota sampling are shown in Supplementary data, Table S4, and age-specific national hospital admission rates and CCG population figures used to estimate CCG costs are shown in Supplementary data, Table S5. The estimated mean total cost for injuries per CCG was £7 265 511 (SD £3 877 346) ranging from a minimum of £1 780 683 to a maximum of £25 563 203 (Supplementary data, Figure S2). The total estimated cost across all 211 CCGs was £1 533 022 790.

Table 1 Baseline socio-demographic characteristics, pre-injury health status and injury characteristics (percentage unless otherwise stated)

Characteristics	*Frequency (%)*
Study centre	
Nottingham	278 (41.6)
Loughborough	167 (25.0)
Bristol	174 (26.1)
Surrey	49 (7.3)
16–24 years	96 (14.4)
25–44 years	178 (26.7)
45–64 years	310 (46.4)
65+ years	84 (12.6)
Female	316 (47.3)
Male	352 (52.7)
Black or minority ethnic group	34 (5.1)
White	634 (94.9)
Marital status [5]	
Single	189 (28.5)
Married/civil partnership	360 (54.3)
Divorced/widowed	114 (17.2)
Lives alone	120 (18.0)
Employment [8]	
In paid employment	393 (59.6)
Unable to work due to illness or disability	32 (4.9)
Unemployed and looking for work	26 (3.9)
At home and not looking for work	18 (2.7)
Retired	130 (19.7)
Other	61 (9.2)
Median IMD score (IQR) [17]	13.5 (7.4, 22.9)
Body part injured	
Facial/eye fracture/injury	7 (1.1)
Internal organ injury	7 (1.1)
Spinal injury	2 (0.3)
Spine/vertebrae fracture	21 (3.1)
Pelvis fracture	10 (1.5)
Hip fracture	62 (9.3)
Lower extremity fracture	297 (44.5)
Lower extremity other	27 (4.0)
Upper extremity fracture	75 (11.2)
Upper extremity other injury	15 (2.3)
Superficial injury	10 (1.5)
Other injury	12 (1.8)
Multiple injuries	123 (18.4)
Injury mechanism	
Fall/stumble/trip/jump	425 (63.6)
Traffic injury event (RTA)	142 (21.3)
Struck by object/person	47 (7.0)
Penetrating/piercing injury	16 (2.4)
Physical over exertion	16 (2.4)
Other	22 (3.3)
Location of injury [1]	
Home	142 (21.3)
Work	63 (9.5)
Road	200 (30.0)
Countryside	76 (11.4)
Sports	83 (12.4)
Other	103 (15.4)
Maximum injury severity [2]	
Minor (AIS = 1)	44 (6.6)
Moderate (AIS = 2)	471 (70.7)
Serious or greater (AIS ≥3)	151 (22.7)
Median nights in hospital on index admission (IQR) [21]	6 (3, 10)
Limiting long-standing illness [6]	164 (24.8)
Median EQ5D utility index (IQR) [2]	1 (0.85, 1)

[ ] missing values.

Supplementary data, Table S6 show the mean costs of injury and national hospital admission rates for injury by age group using the multiple imputed costs of injury. The estimated mean total cost for injuries per CCG was £7 755 634 (SD £4 147 121) ranging from a minimum of £1 893 530 to a maximum of £27 431 894 (Supplementary data, Figure S2a). The total estimated cost across all 211 CCGs was £1 636 438 260.

Discussion

Main findings

Our study shows that injuries in working age adults requiring hospital admission result in high levels of NHS primary and secondary care use during the year following the injury. Service use decreases over time, but 62% of participants still used secondary care and 47% used primary care services for injury-related reasons between 5 and 12 months post-injury. The mean cost per participant per injury was £4691, with hip fractures (£5159), lower extremity fractures (£4969) and multiple injuries (£4969) incurring the highest mean costs. Most of the costs were for secondary care services (87%), but 10% of the costs were incurred in primary care. The estimated mean total cost for injuries per CCG was £7.3 million, ranging from £1.8 million to £25.6 million. The total estimated cost across all CCGs in England was £1.53 billion.

What is already known on this topic?

Few studies have directly measured resource use and costs of medically attended injuries in general injury populations in the UK. Previous studies have excluded multiple injuries,

Table 2 The use of primary and secondary care services in the first year post-injury (percentage)

Primary/community care use		*<1 month post-injury,* n = *513*	*1–2 months post-injury,* n = *478*	*3–4 months post-injury,* n = *452*	*5–12 months post-injury* n = *421*
GP consultation at surgery		130 (25.3)	144 (30.1)	176 (38.9)	143 (34.0)
GP or practice nurse telephone consultation		135 (26.3)	97 (20.3)	53 (11.7)	41 (9.7)
Practice nurse consultation		104 (20.3)	64 (13.4)	55 (12.2)	56 (13.3)
NHS physiotherapist consultation		35 (6.8)	50 (10.5)	76 (16.8)	50 (11.9)
Consultation with other NHS professional[a]		83 (16.2)	44 (9.2)	55 (12.2)	34 (8.1)
GP consultation at home		22 (4.3)	18 (3.8)	11 (2.4)	7 (1.7)
Community/nurse consultation at home		54 (10.5)	36 (7.5)	23 (5.1)	11 (2.6)
Ambulance service visit		39 (7.6)	20 (4.2)	22 (4.9)	13 (3.1)
Other NHS services at home[b]		41 (8.0)	40 (8.4)	28 (6.2)	14 (3.3)
Used any primary/community care services		343 (66.9)	291 (60.9)	273 (60.4)	197 (46.8)
Secondary care use	Index admission, *n* = 668	<1 month post-injury, *n* = 513	1–2 months post-injury, *n* = 478	3–4 months post-injury, *n* = 452	5–12 months post-injury, *n* = 421
ED attendance	668 (100.0)	37 (7.2)	56 (11.7)	30 (6.6)	23 (5.5)
Hospital admission	668 (100.0)	26 (5.1)	41 (8.6)	22 (4.9)	28 (6.7)
Fracture clinic attendance		310 (60.4)	334 (69.6)	247 (54.7)	142 (33.7)
Other outpatient clinic attendance[c]		94 (18.3)	112 (23.4)	100 (22.1)	115 (27.3)
Hospital physiotherapy attendance		120 (23.4)	204 (42.7)	232 (51.3)	155 (36.8)
Other hospital use[d]		67 (13.1)	58 (12.1)	73 (16.1)	58 (13.8)
Used any secondary care services	668 (100.0)	413 (80.1)	427 (89.3)	368 (81.4)	262 (62.2)

[a]Psychologist/community mental health nurse/counsellor, other community doctor, occupational therapist.

[b]Occupational therapist, physiotherapists and other professionals.

[c]Burns clinic, hospital day case, other outpatient clinic.

[d]Occupational therapist, other services at the hospital.

Table 3 Receipt of NHS aids, appliances and adaptations and prescribed medications (percentage)

	<1 month post-injury, n = *513*	*1–2 months post-injury,* n = *478*	*3–4 months post-injury,* n = *452*	*5–12 months post-injury,* n = *421*
Number of participants receiving aids, adaptations and appliances				
Wheelchair	20 (3.9)	8 (1.7)	6 (1.3)	3 (0.7)
Walking frame	59 (11.5)	29 (6.1)	9 (1.9)	3 (0.7)
Crutches	136 (26.5)	84 (17.6)	49 (10.1)	19 (4.5)
Toilet modifications	45 (8.8)	13 (2.7)	10 (2.2)	8 (1.9)
Stool/chair	26 (5.1)	9 (1.9)	6 (1.3)	1 (0.2)
Other	40 (7.8)	27 (5.6)	24 (5.3)	11 (2.6)
Received any aids, adaptations or appliances	192 (36.8)	114 (23.8)	68 (15.0)	31 (7.3)
Number of participants prescribed medication by BNF chapter				
Gastrointestinal system	43 (8.3)	20 (4.2)	12 (2.7)	9 (2.1)
Central nervous system	435 (84.8)	266 (55.6)	187 (41.4)	114 (27.1)
Infections	16 (3.1)	11 (2.3)	10 (2.2)	3 (0.7)
Nutrition and blood	16 (3.1)	17 (3.6)	18 (4.0)	17 (4.0)
Musculoskeletal and joint diseases	124 (24.2)	71 (14.9)	50 (11.1)	44 (10.5)
Other	23 (4.5)	7 (1.5)	13 (2.8)	12 (2.9)
Prescribed any medications	450 (87.7)	290 (60.7)	213 (47.1)	147 (34.9)

Table 4 Mean (standard deviation) healthcare costs up to 12 months post-injury by injury type and resources used (£)[a]

Type of injury (n = *328)*	*Primary care*	*Secondary care*	*Aids, appliances and adaptations*	*Medication*	*Total cost*
Multiple injuries (*n* = 68)	527.0 (808.2)	4298.8 (1652.2)	72.0 (120.1)	71.0 (101.9)	4969.3 (1913.2)
Hip fracture (*n* = 32)	1101.6 (2089.3)	3795.5 (1013.6)	166.6 (223.8)	95.5 (104.0)	5159.1 (2605.1)
Lower extremity fracture (*n* = 146)	413.1 (756.2)	4397.3 (2268.3)	71.7 (123.2)	87.2 (167.2)	4969.3 (2652.2)
Spine, vertebrae fracture (*n* = 10)	286.6 (247.1)	3371.0 (528.8)	18.8 (47.1)	102.5(116.0)	3778.9 (640.6)
Lower extremity other injury (*n* = 10)	431.2 (527.0)	2998.1 (1316.7)	40.4 (57.0)	15.7 (20.6)	3485.4 (1535.7)
Upper extremity fracture (*n* = 42)	153.6 (193.1)	3508.5 (1400.1)	7.5 (28.1)	17.1 (17.2)	3686.8 (1420.6)
Other injuries (*n* = 20)	196.6 (298.9)	3855.7 (2308.6)	11.7 (26.8)	69.2 (98.1)	4133.1 (2462.8)
All injuries (*n* = 328)	454.3 (938.0)	4097.4 (1925.5)	66.6 (128.2)	72.8 (131.1)	4691.1 (2342.0)

[a]Based on 328 participants who completed all follow-up questionnaires.

focussing on secondary care costs and excluding primary care costs. Hip fractures and lower limb fractures have been found to incur the highest costs.[8,9]

What this study adds?

This is the largest study quantifying UK NHS service use and costs among unintentionally injured working age adults. A major strength of our study is self-reported resource-use data allowing costing a wide range of primary and secondary care service use. We identified participants with multiple injuries, readmissions and day cases. Our study extends the work of the EUROCOST and APOLLO studies whose costing is based only on secondary care resource use and on average resource use by injury type (e.g. average length of stay). Our study includes participants of both sexes, aged 16–70, with a wide range of unintentional injuries, from multiple English NHS hospitals, so our findings should be generalizable to general injury populations attending or admitted to similar hospitals. The economic analysis followed standard methods for cost analysis[18] and good practice guidelines for costing medications.[11] Our findings should therefore be comparable with other studies using these methods to cost healthcare resource use for injuries or other conditions.

Limitations of this study

Some injury types only occurred in a few participants (e.g. spine/vertebral injury), making cost estimates subject to considerable uncertainty. Our follow-up rates were higher than some prospective studies of general injury populations[4,19,20] and similar to other studies,[21,22] but it is possible that some response bias occurred. We could not collect data on characteristics of non-participants making assessment of any possible selection bias difficult. Results from analyses using imputed costs for non-responders to the follow-up questionnaires gave slightly higher cost estimates than those from participants who completed all four follow-up questionnaires, reflecting differences in socio-demographic and injury characteristics between these groups.

Where participants reported a hospital admission or ED attendance for their injury in their 1-month follow-up questionnaire, we used reasons given for the attendance to distinguish between index admissions or ED attendance or to re-admission or re-attendance. Where there was uncertainty, we assumed they were reporting the index event. This may have led to underestimation of resource use and costs. We were unable to find any recent data on hospital readmission rates post-injury in the UK, but the self-reported readmission rate in the first month post-injury (5.1%) is very similar to that reported in a recent Canadian general injury population multicentre cohort study (5.9%).[23] If participants did not report drug use length, we assumed the drug was used for the entire period covered by that questionnaire, which may overestimate the drug costs, particularly at later time points when the questionnaires covered longer time periods. Given that drug costs comprise only 1–2% of total costs per injury, this is unlikely to have a major impact on our cost estimates.

Our cost estimates only account for NHS resource use in the first 12 months post-injury. Previous studies have shown that injured working age adults have higher rates of health service use than the general population, in some cases for many years post-injury;[24] hence, our estimates do not represent the total NHS costs of injuries. Our CCG cost estimates intent to indicate the likely scale of costs for CCGs. They are based on the injury average age-specific cost across all injuries and the age-specific number of injuries per CCG estimated using national admissions data. Costs per injury type were not used for this calculation given the small number of participants with some types of injuries. Our estimates assume that the case-mix of injuries in a CCG is similar to that of our study population and that CCGs have the same age-specific injury rates as those for England as a whole. As our study is based upon UK cost weights, our findings are not directly transferrable to other countries. We measured costs in terms of 'resources used' rather than 'spending'. Therefore, the study measures economic costs not budget spending. If the results are to inform budgets for injury-related services, then a technique such as Budget Impact Analysis should be used.[25] Finally, there is a large body of literature showing that a range of factors in addition to hospital admission, length of stay, injury type and injury severity are associated with injury recovery, some of which are potentially modifiable.[6,20,21,26–36] These factors may also influence the cost of injuries, and further research to identify cost predictors and the impact of potentially modifiable factors on cost is required.

Conclusions

This study has shown high levels of health service use that incur large NHS costs among working age adults in the UK in the first year post-injury. These cost data can be used to inform injury prevention policies and strategies and health service planning. There is potential to reduce costs through commissioning and provision of effective injury prevention interventions. Further research is needed to identify factors associated with higher cost injuries and to explore the potential for cost savings by targeting prevention and rehabilitation at modifiable factors associated with higher cost injuries.

Supplementary data

Supplementary data are available at *PUBMED* online.

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References

1 Office for National Statistics (ONS). Deaths Registered in England and Wales 2012. http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-325289 [23 May 14, date last accessed].

2 Health and Social Care Information Centre. Hospital Episode Statistics, Admitted Patient Care, England 2012–13: External causes. http://www.hscic.gov.uk/catalogue/PUB12566/hosp-epis-stat-admi-ext-caus-2012-13-tab.xlsx [23 May 14, date last accessed].

3 Department for Trade and Industry. *24th (Final) Report of the Home and Leisure Accident Surveillance System, 2000, 2001 and 2002 Data*. London: Department for Trade and Industry, 2003.

4 Lyons RA, Kendrick D, Towner EM *et al*. Measuring the population burden of injuries—implications for global and national estimates: a multi-centre prospective UK longitudinal study. *PLoS Med* 2011; **8(12)**:e1001140.

5 Kendrick D, Vinogradova Y, Coupland C *et al*. Getting back to work: the UK Burden of Injury multicentre longitudinal study. *BMC Public Health* 2012;**12**:584.

6 Kendrick D, Vinogradova Y, Coupland C *et al*. Recovery from injury: the UK burden of injury multicentre longitudinal study. *Inj Prev* 2013;**19**(**3**):370–81.

7 Polinder S, Meerding WJ, Toet H *et al*. *A Surveillance Based Assessment of Medical Costs of Injury in Europe: Phase 2*. Amsterdam: Erasmus, MC; Consumer Safety Institute, 2004.

8 Polinder S, Meerding WJ, van Baar ME *et al*. Cost estimation of injury-related hospital admissions in 10 European countries. *J Trauma* 2005;**59(3)**:1283–91.

9 Polinder S, Toet H, Mulder S *et al*. *APOLLO: The Economic Consequences of Injury - Final Report*. Consumer and Safety Institute Amsterdam, The Netherlands: European Commission, 2008.

10 Kendrick D, O'Brien C, Christie N *et al*. The impact of injuries study. Multicentre study assessing physical, psychological, social and occupational functioning post-injury-a protocol. *BMC Public Health* 2011;**11(1)**:963.

11 Hay JW, Smeeding J, Carroll NV *et al*. Good research practices for measuring drug costs in cost effectiveness analyses: issues and recommendations: the ISPOR Drug Cost Task Force Report—Part I. *Value Health* 2010;**13(1)**:3–7.

12 National Institute for Helath and Care Excellence (NICE). Medicines and prescribing National Institute for Helath and Care Excellence (NICE), 2015. http://www.nice.org.uk/about/nice-communities/medicines-and-prescribing#ADQ (13 December 2014, date last accessed)

13 World Health Organisation (WHO). Introduction to drug utilisation research, 2003. http://www.whocc.no/filearchive/publications/drug_utilization_research.pdf (13 December 2014, date last accessed).

14 Joint Formulary Committee. *British National Formulary*, 63 edn. London: BMJ Group and Pharmaceutical Press, 2012.

15 Curtis L (ed). *Unit Costs of Health and Social Care 2012*. Canterbury: Personal Social Services Research Unit, University of Kent, 2012.

16 Personal Social Services Research Unit. *Unit Costs of Health and Social Care*. Canterbury: Social Services Research Unit, 2012.

17 Office for National Statistics (ONS). Estimates of the usual resident population as at 30 June 2012 for health geographies in England (including current areas and former Primary Care Organisations). 2012. http://www.ons.gov.uk/ons/dcp171778_320900.pdf (5 November 2015, date last accessed).

18 Drummond MF, Sculpher MJ, Torrance GW *et al*. *Methods for the Economic Evaluation of Health Care Programme*, 3rd edn. Oxford: Oxford University Press, 2005.

19 Meerding WJ, Looman CW, Essink-Bot ML *et al*. Distribution and determinants of health and work status in a comprehensive population of injury patients. *J Trauma* 2004;**56(1)**:150–61.

20 Polinder S, van Beeck EF, Essink-Bot ML *et al*. Functional outcome at 2.5, 5, 9, and 24 months after injury in the Netherlands. *J Trauma* 2007;**62(1)**:133–41.

21 Holbrook TL, Anderson JP, Sieber WJ *et al*. Outcome after major trauma: 12-month and 18-month follow-up results from the Trauma Recovery Project. *J Trauma Injury Infect Critical Care* 1999;**46(5)**:765–71; discussion 71–3.

22 Langley JD, Lilley R, Wilson S *et al*. Factors associated with non-participation in one or two follow-up phases in a cohort study of injured adults. *Inj Prev* 2013;**19(6)**:428–33.

23 Moore L, Stelfox HT, Turgeon AF *et al*. Rates, patterns, and determinants of unplanned readmission after traumatic injury: a multicenter cohort study. *Ann Surg* 2014;**259(2)**:374–80.

24 Cameron CM, Purdie DM, Kliewer EV *et al*. Ten-year health service use outcomes in a population-based cohort of 21,000 injured adults: the Manitoba injury outcome study. *Bull World Health Organ* 2006;**84(10)**:802–10.

25 Sullivan SD, Mauskopf JA, Augustovski F *et al*. Budget impact analysis—principles of good practice: report of the ISPOR 2012 Budget Impact Analysis Good Practice II Task Force. *Value Health* 2014;**17(1)**:5–14.

26 Clay FJ, Newstead SV, Watson WL *et al*. Bio-psychosocial determinants of persistent pain 6 months after non-life-threatening acute orthopaedic trauma. *J Pain* 2010;**11(5)**:420–30.

27 Haagsma J, Polinder S, Olff M *et al*. Posttraumatic stress symptoms and health-related quality of life: a two year follow-up study of injury treated at the emergency department. *BMC Psychiatry* 2012;**12**:1.

28 Holbrook TL, Anderson JP, Sieber W *et al*. Outcome after major trauma: discharge and 6-month follow-up results from the Trauma Recovery Project. *J Trauma Injury Infect Critical Care* 1998;**45(2)**:315–24.

29 Holmes A, Williamson O, Hogg M *et al*. Predictors of pain 12 months after serious injury. *Pain Med* 2010;**11(11)**:1599–611.

30 Kiely JM, Brasel KJ, Weidner KL *et al*. Predicting quality of life six months after traumatic injury. *J Trauma Acute Care Surg* 2006;**61(4)**:791–8.

31 Langley J, Derrett S, Davie G *et al*. A cohort study of short-term functional outcomes following injury: the role of pre-injury socio-demographic and health characteristics, injury and injury-related healthcare. *Health Qual Life Outcomes* 2011;**9(1)**:68.

32 Derrett S, Samaranayaka A, Wilson S *et al*. Prevalence and predictors of sub-acute phase disability after injury among hospitalised and non-hospitalised groups: a longitudinal cohort study. *PLoS ONE* 2012;e44909.

33 O'Donnell ML, Creamer M, Elliott P *et al*. Determinants of quality of life and role-related disability after injury: impact of acute psychological responses. *J Trauma Injury Infect Critical Care* 2005;**59(6)**:1328–35.

34 Ottosson C, Nyren O, Johansson S-E *et al*. Outcome after minor traffic accidents: a follow-up study of orthopedic patients in an inner-city area emergency room. *J Trauma Injury Infect Critical Care* 2005;**58(3)**:553–60.

35 Ponsford J, Hill B, Karamitsios M *et al*. Factors influencing outcome after orthopedic trauma. *J Trauma* 2008;**64(4)**:1001.

36 Ponzer S, Bergman B, Brismar B *et al*. A study of patient-related characteristics and outcome after moderate injury. *Injury* 1996;**27(8)**:549–55.

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